

School Energy Use Benchmarking and Monitoring in the West Contra Costa Unified School District

By

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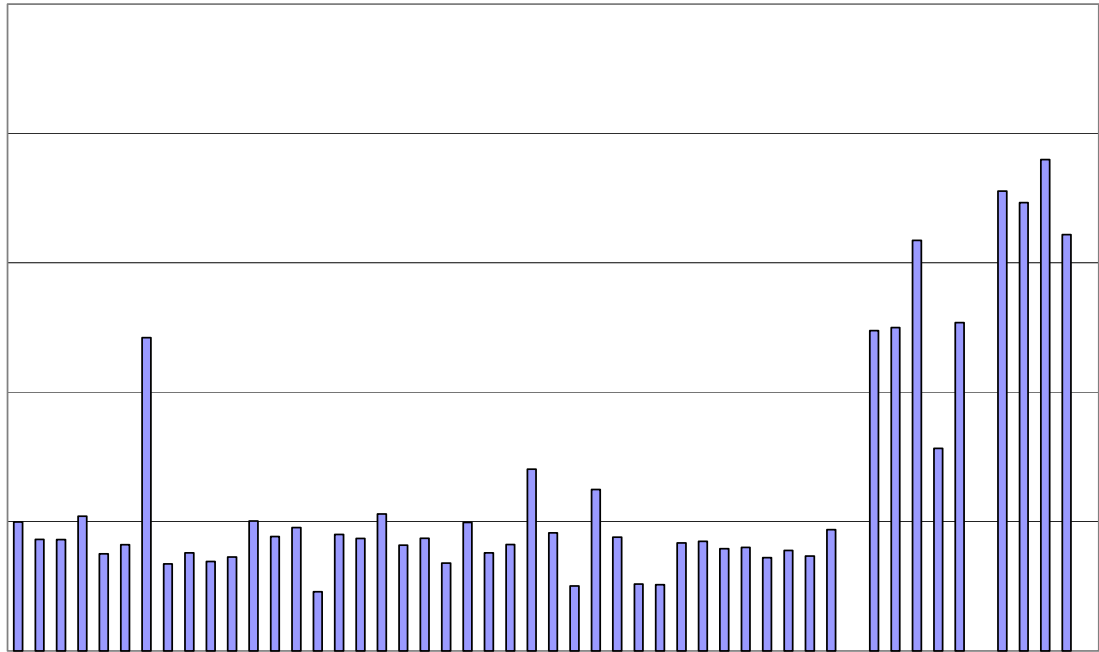
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FIGURE 1 THE WESTERN PAR

FIGURE 32 HANNA RAN

-5set of benchmarking tools for school energy consumption is being developed, using energy consumption data from schools in the WCCUSD. Data from thirty-nine elementary schools, five elementary schools, five m



[illegible]

Relative Energy Consumption

Absolute energy consumption figures provide a good indicator of a building's efficiency when compared to similar buildings. However, a better indicator of the efficiency of a building is the energy consumption per unit of reference. Similarly, a better indicator of the cost-effectiveness of a building is the energy cost per unit of reference. In our particular case, the units of reference used are units of area (ft²) and student population. Appendix C shows the school energy consumption and cost per student, while Appendix D presents the school energy consumption and cost per unit of area. These indicators permit a comparison of the performance of the schools independently of their size or student population.

The energy use per student and energy cost per student for the WCCUSD schools are presented in Figure 9 and Figure 10 respectively on the next page. Statistics for the total energy and cost per student are presented in Table 5.

High schools, on average, consume more energy per student than middle and elementary schools. Also the energy cost per student is bigger for the high schools.

Table 5 School Energy Statistics per Student.

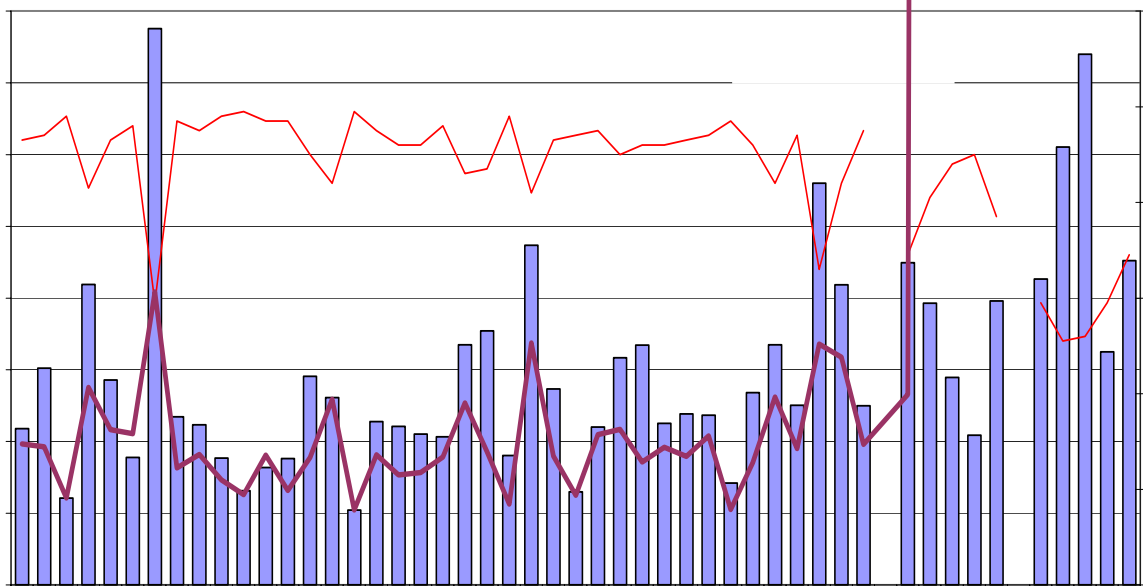
Elementary Schools

Middle Schools



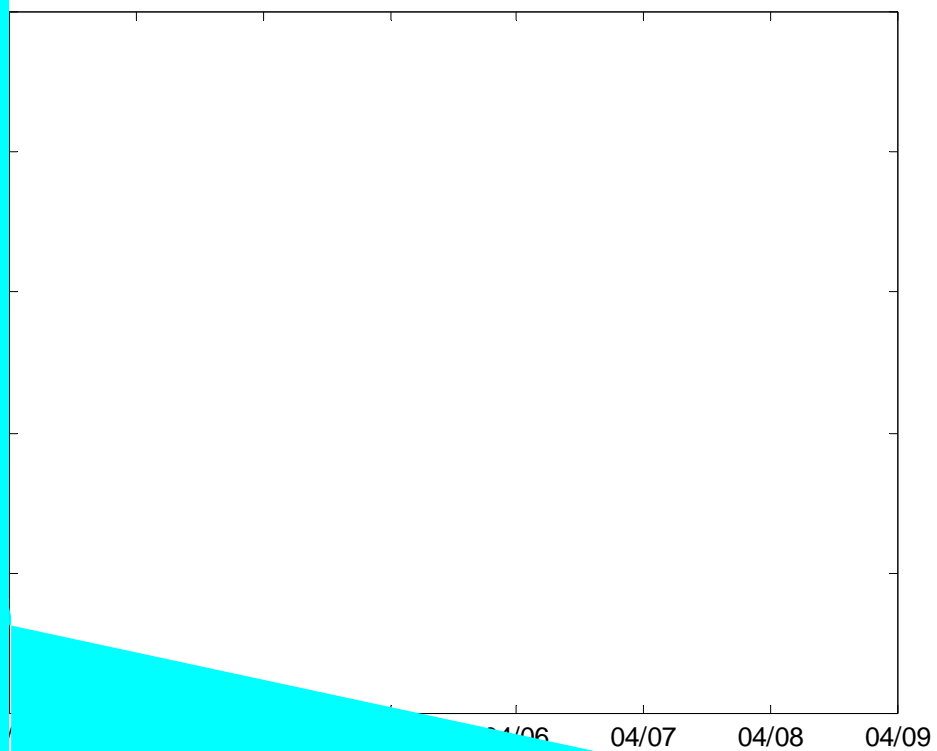
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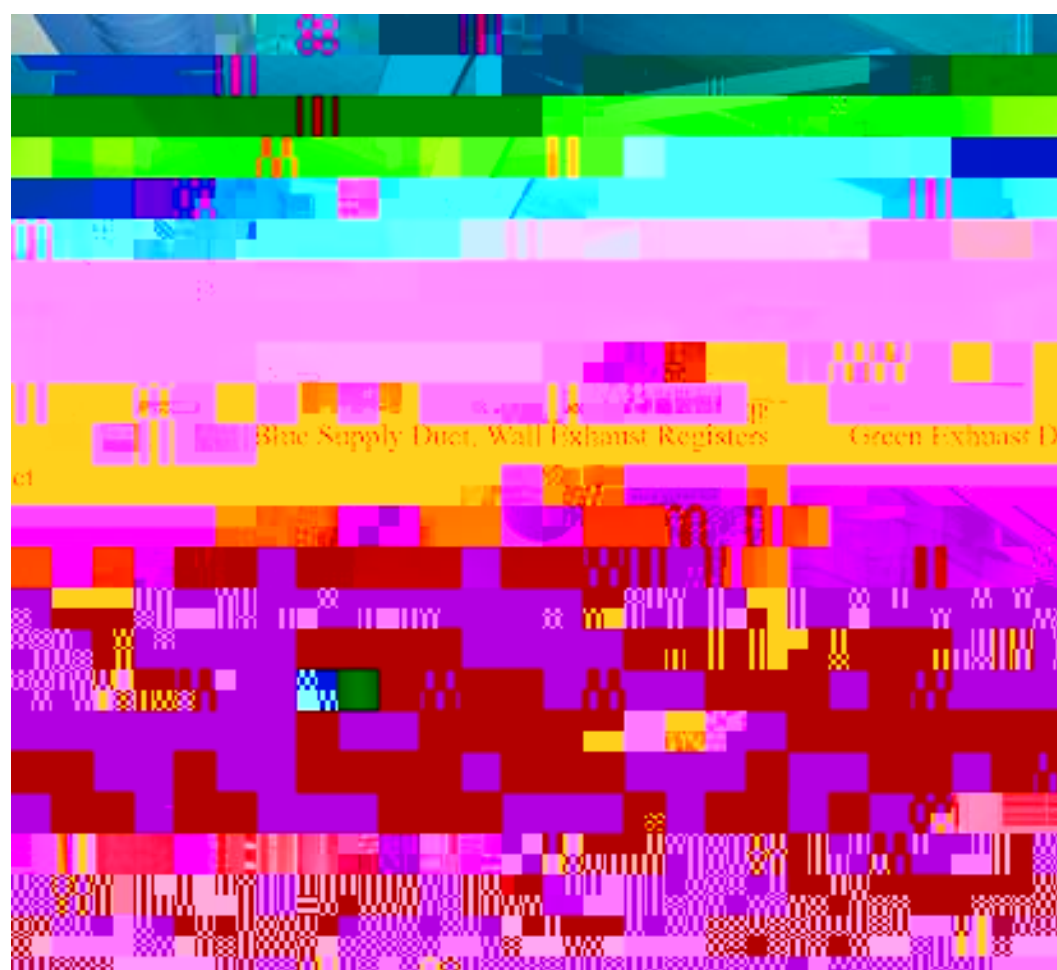
are not high schools but elementary schools. Energy cost per unit area is approximately the same for elementary and m



School Power and Energy Monitoring

Multi-purpose Room,





The loads monitored by the NILM and K20 system

equipment and classroom loads, operated during the daytime when the school was occupied (Figure 30: first five days; Figure 31: second and third days). In addition to the normal equipment, the June week waveform also shows that the kiln was used. These observations were verified using the data obtained from the parallel sub-metering system.

Figure 32 presents the K20 and NILM waveforms fromverif3 32 presen3s the K20 and NILM27000812 324760

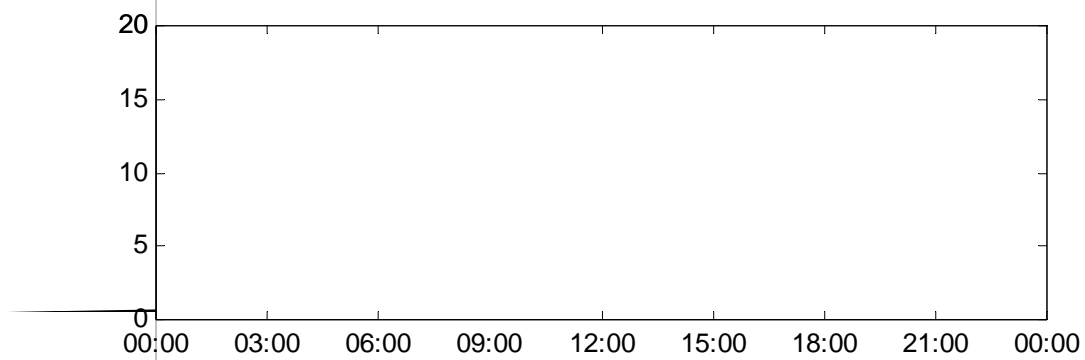
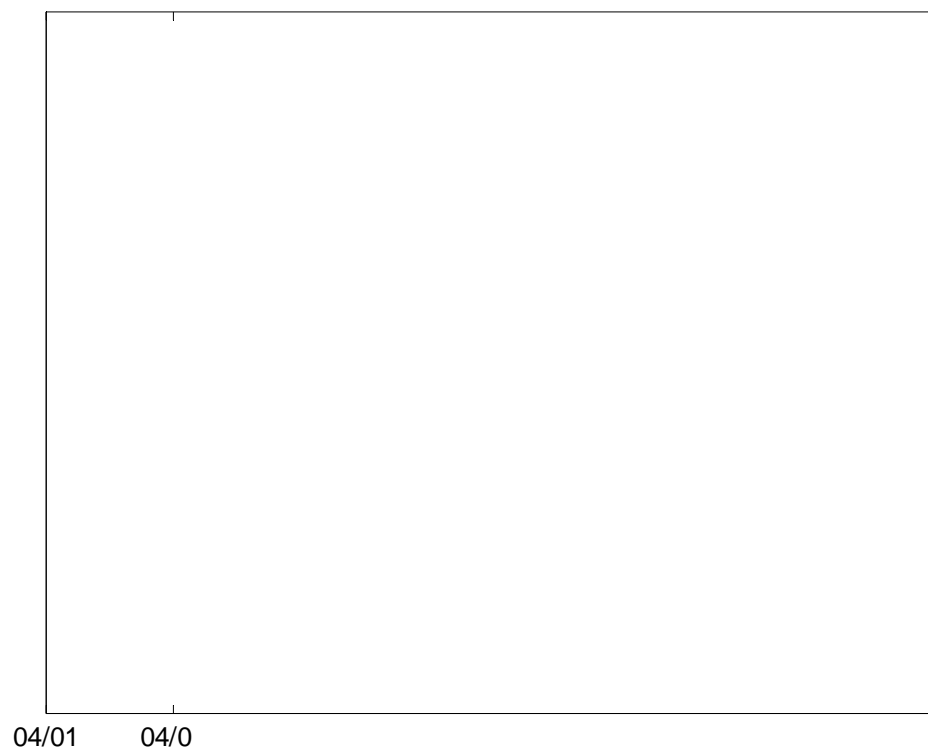


Figure 34 shows a comparison between the NILM power waveform and the power consumption recorded by the K20 system on the kiln channel (channel 8) during a period the kiln operated. It can be seen that kiln oscillations are observable in the NILM waveform, while they are not in the nsum

Pinole Middle School

The Pinole Middle School is composed of a main building (Figure 36) -housing 22 classrooms, a multipurpose room, the cafeteria and the administrative offices- and a secondary building housing the library. Furthermore there a3.26422 6ortab Scassroom

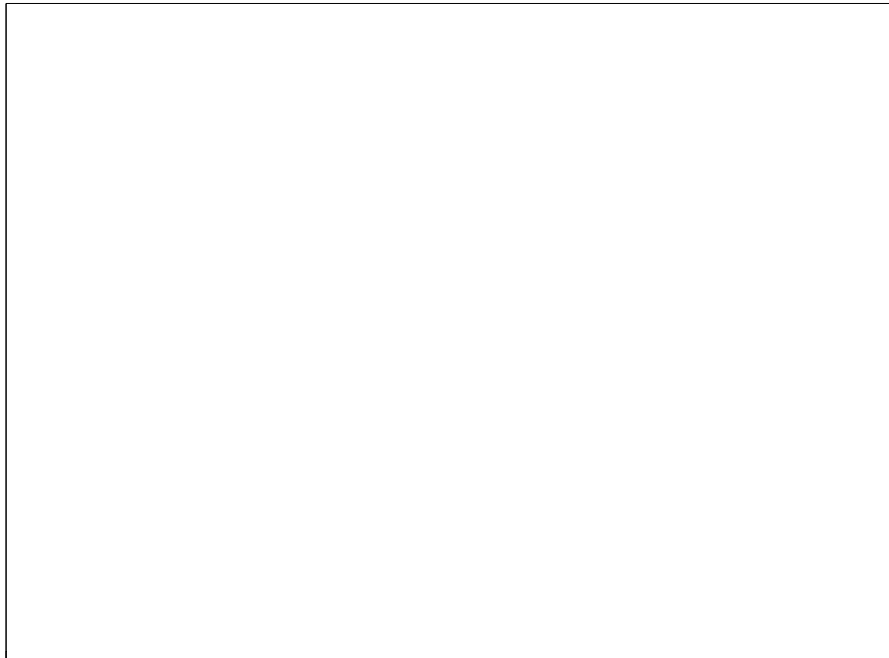


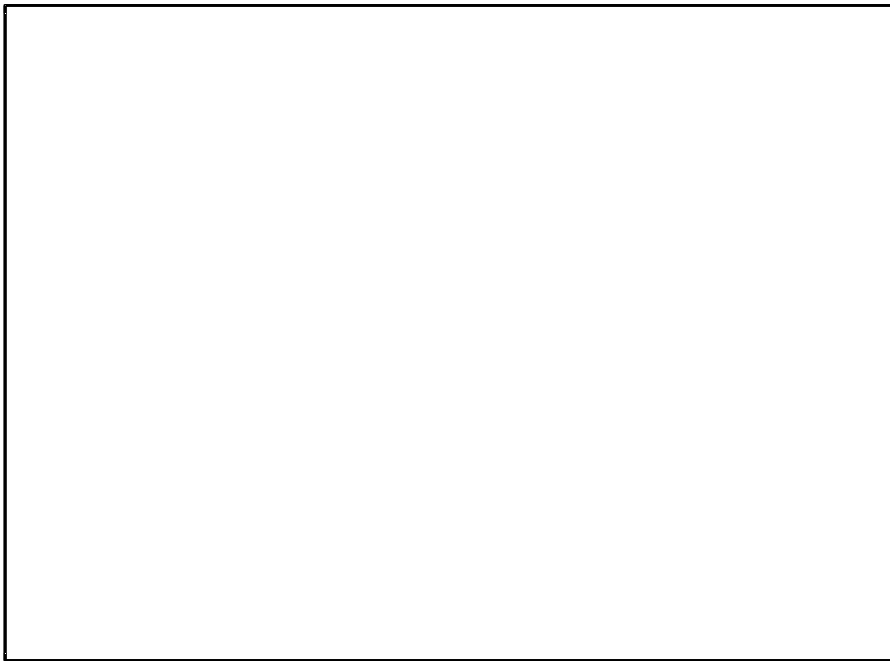
In addition to the consumption patterns described previously, the power waveforms of the March week (Figure 37) and the April holiday weeks (Figure 39) also show atypical power oscillations which could be indicative of potentially abnormal behavior of one or more devices. A sample of these oscillations, from the afternoon of March 4, is presented in Figure 41.

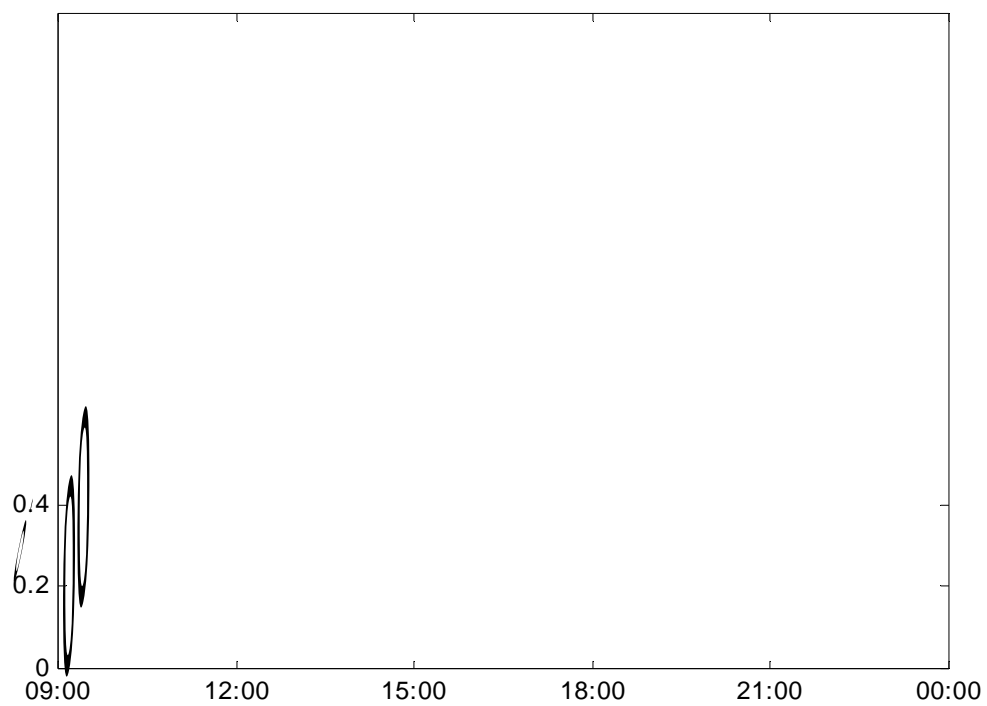


Secondary Distribution Panel

A NILM machine and a K20 parallel monitoring system were installed on the secondary electrical distribution panel of the Pinole Middle School that services the lights and receptacles of four classrooms. A sample of the real power recorded by the NILM on phase A of the sub-panel is presented in Figure 43 below.







The lights in room 17 consumed the least amount of energy am

WCCUSD Facilities Design Team (June 25, 2002)

with newer high efficiency equipment. Changes in building insulation and air infiltration.

Design changes in buildings, such as daylighting, passive cooling and heating

School Monitoring Discussion

€# Energy consumption results for demonstration classrooms and control classroom Pinole Middle School were presented. The lighting retrofits in the demonstration classroomslighting rea savings of 20% in energy consum ption compar reto the lights in

equipment operation, such as the kiln, kiln fan and exhaust fans other than classroom fans, and settings of the nighttime lights.

Contribution

School	Energy Intensity per Hour (kBtu/ft ² -hr)			Energy per Student-Hour (kBtu/person-hr)		
	Electricity	Gas	Total	Electricity	Gas	Total
Harding	1.425	1.908	3.33	155.3	207.9	363.25

Rank	Energy per Area	Cost per Area	Energy per Student	Cost per Student	Energy per Student-Hr	Energy per ft ² -Hr	Total Energy	Total Cost
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Appendix H Meeting Attendees Cont